has been completed, when the piston uncovers a ring of ports in the wall of the cylinder which communicate with the condenser, the pressure in the cylinder thus falling to very nearly that in the condenser. On the return stroke the ports are closed by the advancing piston, and the steam left in the cylinder is compressed until it has attained a pressure nearly equal to that of the incoming steam. The process of compression raises the temperature of the steam, the cylinder walls, the cylinder-cover faces, and the piston. As the steam enters at one end of the cylinder and leaves at w[r]hat may be called the other end, there is a gradual fall of temperature in the cylinder metal from the inlet end. Further, the steam when exhausting does not scour the surfaces at the inlet end and so reduce their temperature by abstracting heat, although the temperature must fall to some extent by adiabatic expansion during the brief exhaust period, but heat is restored by the subsequent compression. Some of the heat generated by compression must be lost by conduction, and the work expended is not wholly recovered in the subsequent power stroke; but the total effect of the arrangement is that initial condensation is greatly reduced and the efficiency improved, compared with single expansion in the ordinary type of engine.

It has been seen that there are many disturbing factors which interfere with the ideal performance of a steam-engine, such as initial condensation, re-evaporation, leakage, conduction, and radiation, all leading to uncertainty with regard to the conditions under which the expansion of steam takes place. This uncertainty, taken together with the fact that the cycle is neither complete nor reversible from a thermodynamic point of view, makes a rational theory difficult, and perhaps unattainable.

The injunction to keep the steam warm, and the avoiding of throttling and large clearances, embody the whole philosophy and practice of design from the thermal point of view, and little progress has been made since Watt laid down the axiom " that the cylinder should be kept as hot as the steam which enters it". Having borne these considerations in mind,

designers can do little more, and have been perforce contented with the possibility of ascertaining and checking the performance of their engines by the method of weighing the condensed steam, introduced by Willans. The ease with which it is possible to measure electrical loads has made universal the practice of submitting to this test both steam-engines and turbines which drive electrical generators, so that makers are now able to guarantee steam consumptions within very narrow limits.

Current practice is to refer the performance of a steam-engine to that which would be given by an ideal engine working through a special cycle proposed by Rankine. The steam is supposed to be admitted at full steam-chest pressure to the point of cut-off and then expanded adiabatically, that is, without loss or gain of heat, to the back pressure, the steam remaining at that pressure throughout the exhaust stroke. The engine is hot supposed to have any clearance between the piston and cover, or in the ports, and there are no losses of any kind. Under those conditions i Ib. of steam is